Claims

What is claimed is:

1. A method of forming a thin film on a substrate, comprising:

providing the substrate in a chamber;

inserting a composite comprising a porous carrier and an amphiphilic material into the chamber;

in the chamber, setting at least one of a temperature of the composite from about 20 to about 400° C. and a pressure from about 0.000001 to about 760 torr to induce vaporization of the amphiphilic material; and

recovering the substrate having the thin film thereon.

2. The method of claim 1, wherein the substrate comprises at least one of a glass, a glass having an antireflection coating thereon, silica, germanium oxide, a ceramic, porcelain, fiberglass, a metal, a thermoset, and a thermoplastic.

3. The method of claim 1, wherein the porous carrier comprises pores having an average pore size from about 1 micron to about 1,000 microns.

4. The method of claim 1, wherein the porous carrier has a porosity so that it absorbs from about 0.001 g to about 5 g of amphiphilic material per cm^3 of porous carrier.

5. The method of claim 1, wherein the porous carrier comprises at least one of alumina, aluminum silicate, aluminum, brass, bronze, chromium, copper, gold, iron, nickel, palladium, platinum, silicon carbide, silver, stainless steel, tin, titanium, tungsten, zinc, and zirconium.

6. The method of claim 1, after setting at least one of the temperature

and the pressure, keeping the substrate in the chamber for a time from about 10 seconds to about 24 hours.

7. The method of claim 1, wherein the amphiphilic material is represented by at least of Formulae I, II, V, VI, VII, and RY:

$$R_mSiZ_n \qquad (I)$$

where each R is individually an alkyl, fluorinated alkyl, alkyl ether or fluorinated alkyl ether containing from about 1 to about 30 carbon atoms, substituted silane, or siloxane; each Z is individually one of halogens, hydroxy, alkoxy and acetoxy; and m is from about 1 to about 3, n is from about 1 to about 3, and m + n equal 4;

$$R_mSH_n \qquad (II)$$

where R is an alkyl, fluorinated alkyl, an alkyl ether or a fluorinated alkyl ether containing from about 1 to about 30 carbon atoms; S is sulfur; H is hydrogen; m is from about 1 to about 2 and n is from 0 to 1;

RY, where R is an alkyl, fluorinated alkyl, an alkyl ether or a fluorinated alkyl ether containing from about 1 to about 30 carbon atoms and Y is one of the following functional groups: -COOH, SO_3H, $-PO_3$, -OH, and $-NH_2$;

$$RSiNSiR \qquad (V)$$

where R is an alkyl, fluorinated alkyl, an alkyl ether or a fluorinated alkyl ether containing from about 1 to about 30 carbon atoms;

$$R(CH_2CH_2O)_qP(O)_x(OH)_y \qquad (VI)$$

where R is an alkyl, fluorinated alkyl, an alkyl ether or a fluorinated alkyl ether containing from about 1 to about 30 carbon atoms, q is from about 1 to about 10, and x and y are independently from about 1 to about 4; and

$$[R(SiO)_x(OH)_y] \qquad (VII)$$

where R is an alkyl, aromatic, fluorinated alkyl, an alkyl ether or a fluorinated alkyl ether containing from about 1 to about 30 carbon atoms; x is from about 1 to about 4; and y is from about 1 to about 4

8. The method of claim 1, wherein the pressure is set prior to setting the temperature.

9. The method of claim 1, wherein the temperature is set from about 40 to about 350° C and the pressure is set from about 0.00001 to about 200 torr.

10. The method of claim 1, wherein the thin film is formed at a rate of about 0.01 nm/sec or more and about 1 nm/sec or less.

11. The method of claim 1, wherein the thin film has a thickness from about 1 nm to about 250 nm.

12. A system for forming a thin film, comprising:

a film forming chamber in communication with at least one of a heat source and a vacuum system;

a composite comprising a porous carrier and an amphiphilic material positionable within the film forming chamber; and

a substrate on which the thin film is formed positionable within the film forming chamber.

13. The system of claim 12, wherein the film forming chamber is in communication with a heat source and a vacuum system.

14. The system of claim 12, wherein the porous carrier comprises pores having an average pore size from about 5 microns to about 500 microns.

15. The system of claim 12, wherein the composite comprises from about 0.01 g to about 2 g of the amphiphilic material per cm^3 of porous carrier.

16. The system of claim 12, wherein the composite further comprises at least one of a non-polar organic solvent, a film forming catalyst, and a quencher.

17. A film forming composite, comprising:

a porous carrier comprising pores having an average pore size from about 1 micron to about 1,000 microns; and

an amphiphilic material,

wherein the porous carrier has a porosity so that it absorbs from about 0.001 g to about 5 g of amphiphilic material per cm^3 of porous carrier.

18. The film forming composite of claims 17, wherein the porous carrier comprises at least one of alumina, aluminum silicate, aluminum, brass, bronze, chromium, copper, gold, iron, nickel, palladium, platinum, silicon carbide, silver, stainless steel, tin, titanium, tungsten, zinc, and zirconium.

19. The film forming composite of claims 17, wherein the porous carrier comprises pores having an average pore size from about 5 microns to about 500 microns and the porous carrier has a porosity so that it absorbs from about 0.01 g to about 1 g of amphiphilic material per cm^3 of porous carrier.

20. The film forming composite of claims 17, wherein the composite has one of a cylindrical shape, a spherical shape, an oval shape, a tablet shape, a disc shape, a plug shape, a pellet shape, a cubical shape, a rectangular shape, and a conical shape.

21. A method of forming a thin film on a substrate, comprising:

providing the substrate in a chamber;

forming an oxide coating on the substrate in the chamber;

inserting a composite comprising a porous carrier and a POSS amphiphilic material into the chamber;

in the chamber, setting at least one of a temperature of the composite from about 20 to about 400° C. and a pressure from about 0.000001 to about 760 torr to induce vaporization of the POSS amphiphilic material; and

recovering the substrate having the thin film thereon.

22. The method of claim 21, wherein the POSS amphiphilic material comprises at least one selected from the group consisting of poly(p-hydroxybenzylsilsesquioxane); poly(p-hydroxybenzylsilsesquioxane-co-methoxybenzylsilsesquioxane); poly(p-hydroxybenzylsilsesquioxane-co-t-butylsilsesquioxane); poly(p-hydroxybenzylsilsesquioxane-co-cyclohexylsilsesquioxane); poly(p-hydroxybenzylsilsesquioxane-co-phenylsilsesquioxane); poly(p-hydroxybenzylsilsesquioxane-co-bicycloheptylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-p-hydroxy-α-methylbenzyls ilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-methoxybenzylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-t-butylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-cyclohexylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-phenylsilsesquioxane); poly(p-hydroxyphenylethylsilsesquioxane-co-bicycloheptylsilsesquioxane); poly(p-

hydroxy-α-methylbenzylsilsesquioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-p-hydroxybenzylsilsesquioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-methoxybenzylsilsesqu ioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-t-butylsilsesquioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-cyclohexylsilsesquioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-phenylsilsesquioxane); poly(p-hydroxy-α-methylbenzylsilsesquioxane-co-bicycloheptylsilsesquioxane); and poly(p-hydroxybenzylsilsesquioxane-co-p-hydroxyphenylethylsilsesquioxane).

23. The method of claim 21, wherein the thin film is formed at a rate of about 0.05 nm/sec or more and about 0.5 nm/sec or less.